ELECTRONICS

THE DATASHEET OF

GAN140-650FBEZ

GAN140-650FBE

650 V, 140 mOhm Gallium Nitride (GaN) FET in a DFN 5 mm x 6 mm package

19 April 2023 Product data sheet

1. General description

The GAN140-650FBE is a general purpose 650 V, 140 mΩ Gallium Nitride (GaN) FET in a DFN 5 mm x 6 mm surface mount package. It is a normally-off e-mode device offering superior performance.

2. Features and benefits

- Enhancement mode - normally-off power switch
- Ultra high frequency switching capability
- No body diode
- Low gate charge, low output charge
- Qualified for standard applications
- ESD protection
- RoHS, Pb-free, REACH-compliant
- High efficiency and high power density
- Low package inductance and low package resistance

3. Applications

- High power density and high efficiency power conversion
- AC-to-DC converters, totem pole PFC
- DC-to-DC converters
- Fast battery charging, mobile phone, laptop, tablet and USB type-C chargers
- Datacom and telecom (AC-to-DC and DC-to-DC) converters
- Motor drives
- Solar (PV) inverters
- Class D audio amplifiers, TV PSU and LED drivers

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
V_{DS}	drain-source voltage	-55 °C ≤ T_j ≤ 150 °C		-	-	650	V
V_{TDS}	transient drain to source voltage	pulsed; t_p = 1 µs; δ_{factor} = 0.01		-	-	800	V
I_D	drain current	V_{GS} = 6 V; T_{mb} = 25 °C	[1]	-	-	17	A
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	-	113	W
T_j	junction temperature			-55	-	150	°C
Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = 6 V; I_D = 5 A; T_j = 25 °C; Fig. 11; Fig. 12; Fig. 13		-	106	140	mΩ
		V_{GS} = 6 V; I_D = 5 A; T_j = 150 °C; Fig. 11; Fig. 14		-	230	-	mΩ

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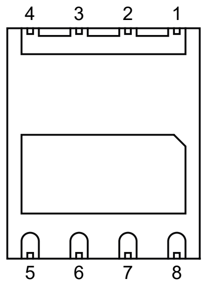
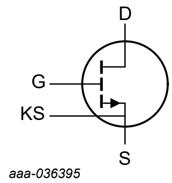
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
R_G	gate resistance	f = 5 MHz; T_j = 25 °C; open drain		-	3.5	-	Ω
Dynamic characteristics							
Q_{GD}	gate-drain charge	I_D = 5 A; V_{DS} = 400 V; V_{GS} = 6 V; T_j = 25 °C; Fig. 15; Fig. 16		-	1.2	-	nC
$Q_{G(tot)}$	total gate charge			-	3.5	-	nC
Q_{oss}	output charge	V_{GS} = 0 V; V_{DS} = 400 V; T_j = 25 °C	[2]	-	33	-	nC

[1] Limited by device saturation

[2] Q_r is not specified separately from Q_{oss} for e-mode GaN FETs, since $Q_r = Q_{oss} + Q_D$, and Q_D = 0. (Q_D is charge associated with diffusion of minority carriers. Since there is no body diode, no minority carriers in excess of Q_{oss} have to be transferred for e-mode GaN FETs.)

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	D	drain	 Transparent top view **DFN5060-5 (SOT8075-1)**	
2	D	drain		
3	D	drain		
4	D	drain		
5	S	source		
6	S	source		
7	KS	kelvin source		
8	G	gate		
mb	S	mounting base; connected to source		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
GAN140-650FBE	DFN5060-5	plastic thermal enhanced small outline package; no leads; 5 terminals; body: 5 × 6 × 0.9 mm	SOT8075-1

7. Marking

Table 4. Marking codes

Type number	Marking code
GAN140-650FBE	140IFBE

8. Limiting values

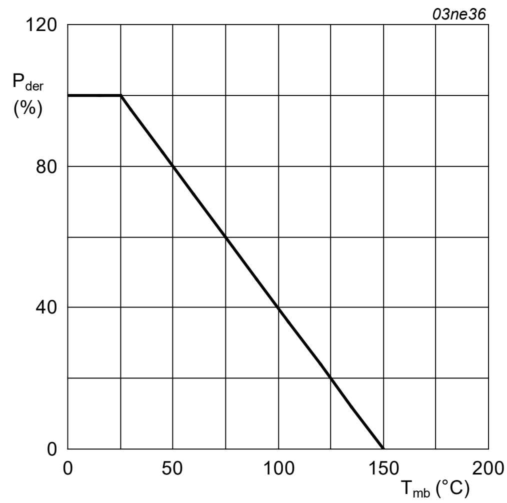
Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).Tj = 25 °C unless otherwise stated.

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage	-55 °C ≤ T_j ≤ 150 °C		-	650	V

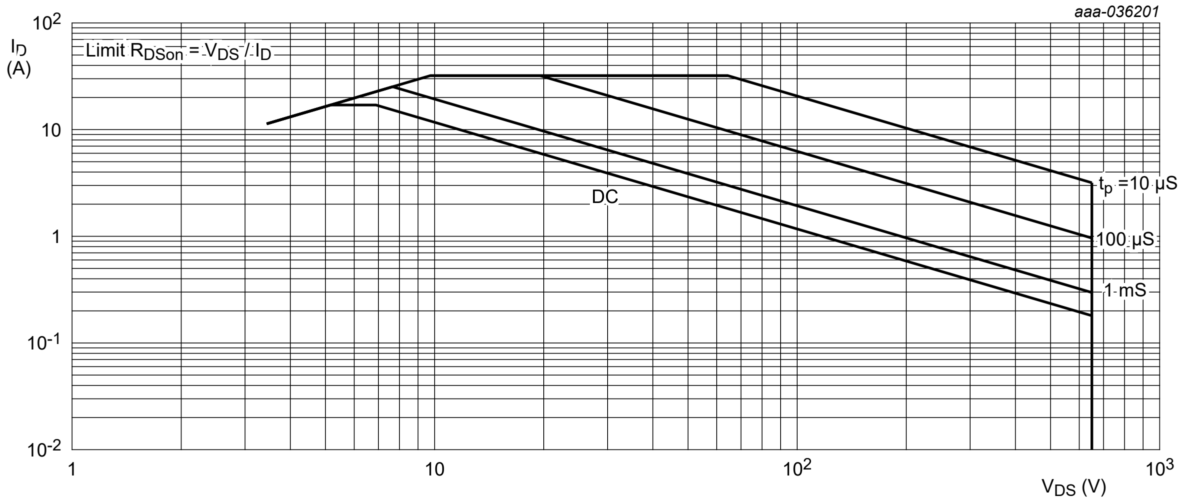
Symbol	Parameter	Conditions		Min	Max	Unit
V_{TDS}	transient drain to source voltage	pulsed; t_p = 1 µs; δ_{factor} = 0.01		-	800	V
V_{GS}	gate-source voltage			-1.4	7	V
P_{tot}	total power dissipation	T_{mb} = 25 °C; Fig. 1		-	113	W
I_D	drain current	V_{GS} = 6 V; T_{mb} = 25 °C	[1]	-	17	A
I_{DM}	peak drain current	pulsed; $t_p \leq$ 10 µs; T_{mb} = 25 °C; Fig. 2	[1]	-	32	A
T_{stg}	storage temperature			-55	150	°C
T_j	junction temperature			-55	150	°C
$T_{sld(M)}$	peak soldering temperature			-	260	°C

[1] Limited by device saturation



$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

Fig. 1. Normalized total power dissipation as a function of mounting base temperature



T_{mb} = 25 °C; I_{DM} is a single pulse

Fig. 2. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-c)}$	thermal resistance from junction to case	Fig. 3		-	-	1.1	K/W
$R_{th(j-a)}$	thermal resistance from junction to ambient			-	-	60.3	K/W

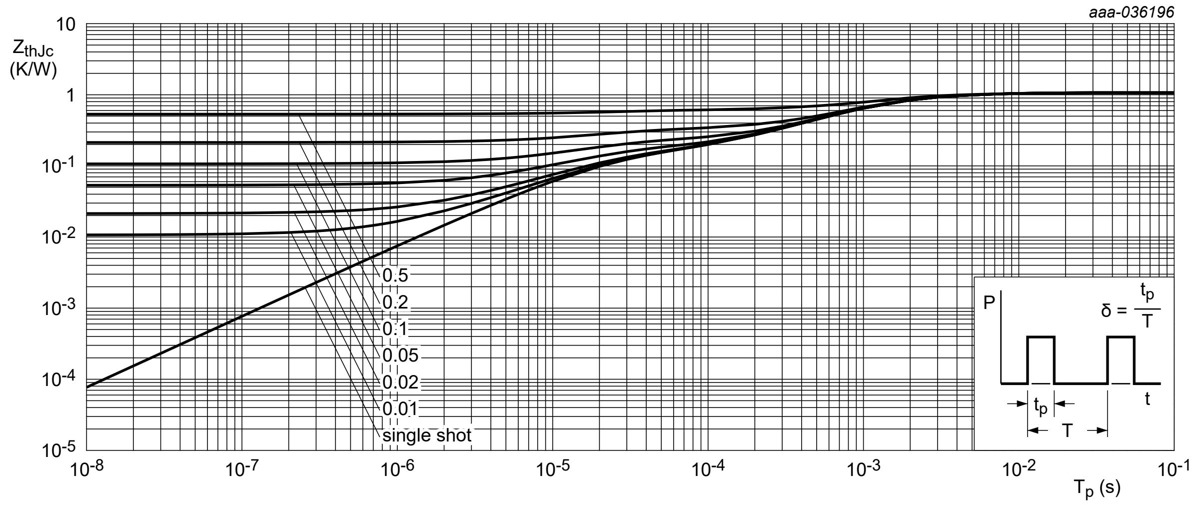


Fig. 3. Transient thermal impedance from junction to case as a function of pulse duration

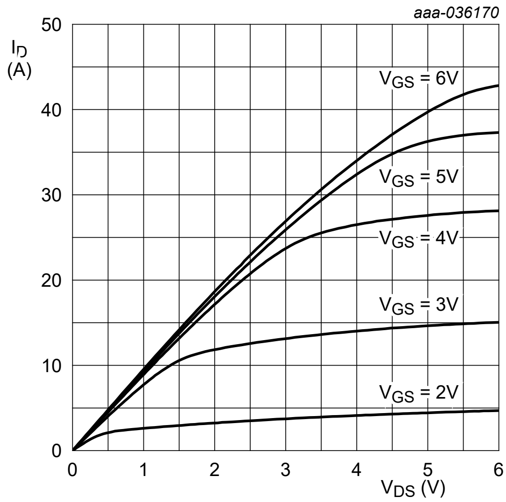
10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Static characteristics							
$V_{GS(th)}$	gate-source threshold voltage	I_D = 17.2 mA; V_{DS} = V_{GS}; T_j = 25 °C; Fig. 8		1.2	1.7	2.5	V
		I_D = 17.2 mA; V_{DS} = V_{GS}; T_j = 150 °C; Fig. 8		-	1.7	-	V
I_{DSS}	drain leakage current	V_{DS} = 650 V; V_{GS} = 0 V; T_j = 25 °C; Fig. 9		-	0.6	25	µA
		V_{DS} = 650 V; V_{GS} = 0 V; T_j = 150 °C; Fig. 9		-	7	-	µA
I_{GSS}	gate leakage current	V_{GS} = 6 V; V_{DS} = 0 V; T_j = 25 °C; Fig. 10		-	70	-	µA
R_{DSon}	drain-source on-state resistance	V_{GS} = 6 V; I_D = 5 A; T_j = 25 °C; Fig. 11; Fig. 12; Fig. 13		-	106	140	mΩ
		V_{GS} = 6 V; I_D = 5 A; T_j = 150 °C; Fig. 11; Fig. 14		-	230	-	mΩ
R_G	gate resistance	f = 5 MHz; T_j = 25 °C; open drain		-	3.5	-	Ω
Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	I_D = 5 A; V_{DS} = 400 V; V_{GS} = 6 V; T_j = 25 °C; Fig. 15; Fig. 16		-	3.5	-	nC
Q_{GS}	gate-source charge			-	0.3	-	nC
Q_{GD}	gate-drain charge			-	1.2	-	nC

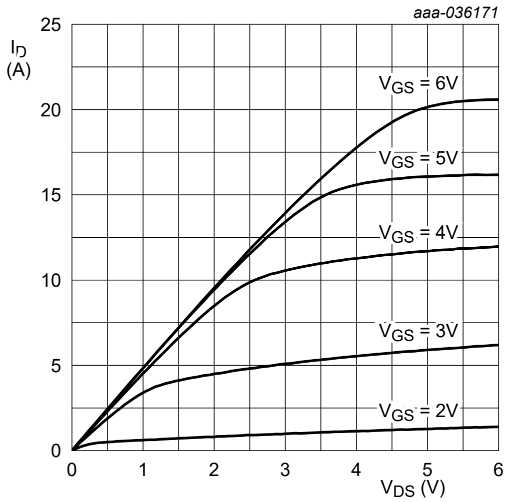
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$V_{GS(pl)}$	gate-source plateau voltage	I_D = 5 A; V_{DS} = 400 V; T_j = 25 °C; Fig. 15		-	2.1	-	V
C_{iss}	input capacitance	V_{DS} = 400 V; V_{GS} = 0 V; f = 100 kHz; T_j = 25 °C; Fig. 17		-	125	-	pF
C_{oss}	output capacitance			-	41	-	pF
C_{rss}	reverse transfer capacitance			-	0.4	-	pF
$C_{o(er)}$	effective output capacitance, energy related	0 V ≤ V_{DS} ≤ 400 V; V_{GS} = 0 V; T_j = 25 °C; Fig. 18	[1]	-	59	-	pF
$C_{o(tr)}$	effective output capacitance, time related	0 V ≤ V_{DS} ≤ 400 V; V_{GS} = 0 V; T_j = 25 °C	[2]	-	82	-	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 400 V; V_{GS} = 6 V; T_j = 25 °C; I_D = 10 A; L = 318 μH; R_{on} = 10 Ω; R_{off} = 2 Ω; Fig. 19; Fig. 20		-	3	-	ns
t_r	rise time			-	5	-	ns
$t_{d(off)}$	turn-off delay time			-	4	-	ns
t_f	fall time			-	4	-	ns
Q_{oss}	output charge	V_{GS} = 0 V; V_{DS} = 400 V; T_j = 25 °C	[3]	-	33	-	nC
Source-drain characteristics							
V_{SD}	source-drain voltage	I_S = 5 A; V_{GS} = 0 V; T_j = 25 °C; Fig. 21; Fig. 22; Fig. 23; Fig. 24		-	2.4	-	V

[1] $C_{O(er)}$ is the fixed capacitance that gives the same stored energy as C_{OSS} while V_{DS} is rising from 0 to 400 V
[2] $C_{O(tr)}$ is the fixed capacitance that gives the same charging time as C_{OSS} while V_{DS} is rising from 0 to 400 V
[3] Q_r is not specified separately from Q_{oss} for e-mode GaN FETs, since $Q_r = Q_{oss} + Q_D$, and Q_D = 0. (Q_D is charge associated with diffusion of minority carriers. Since there is no body diode, no minority carriers in excess of Q_{oss} have to be transferred for e-mode GaN FETs.)



T_j = 25 °C

Fig. 4. Output characteristics: drain current as a function of drain-source voltage; typical values



T_j = 125 °C

Fig. 5. Output characteristics: drain current as a function of drain-source voltage; typical values

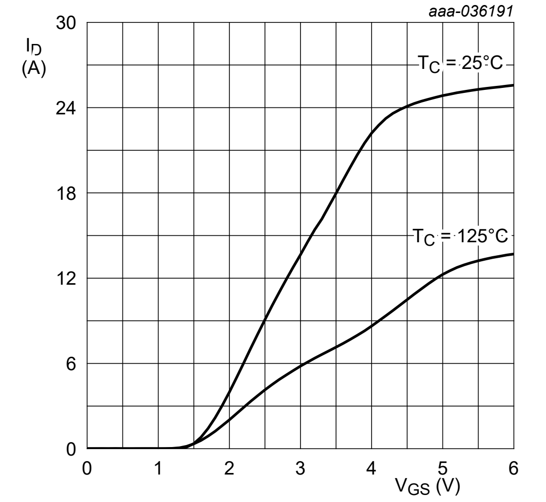
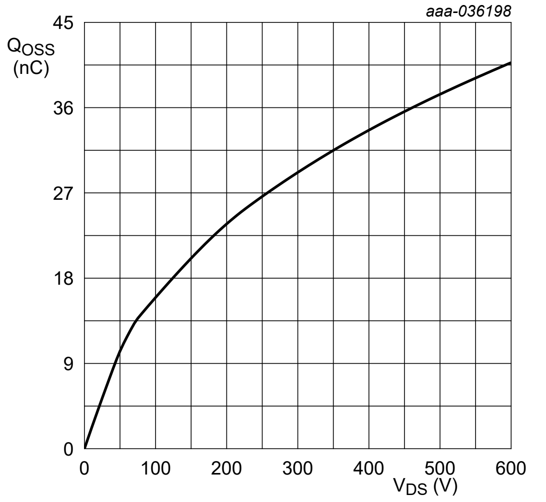
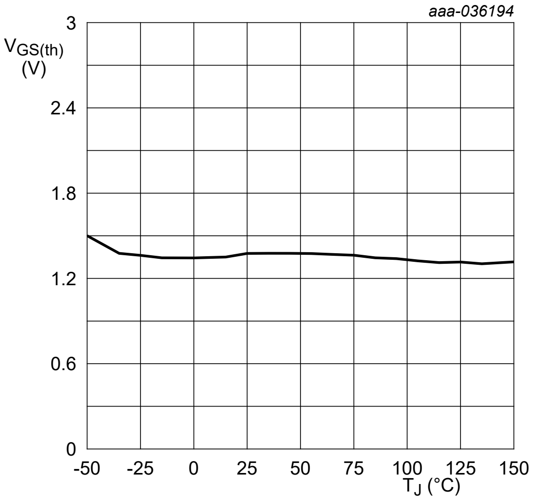


Fig. 6. Transfer characteristics; drain current as a function of gate-source voltage; typical values



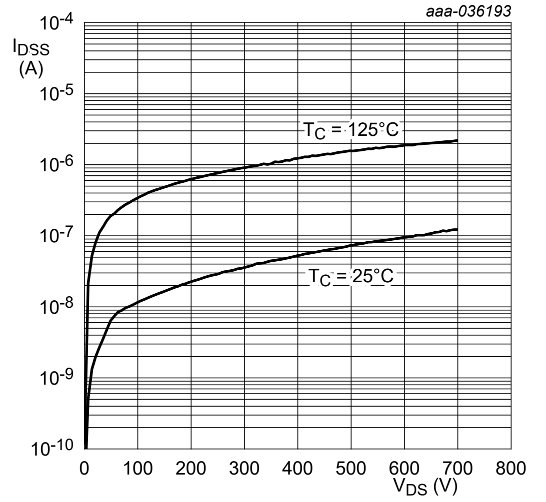
Freq. = 100 kHz

Fig. 7. Output charge as a function of drain-source voltage; typical values



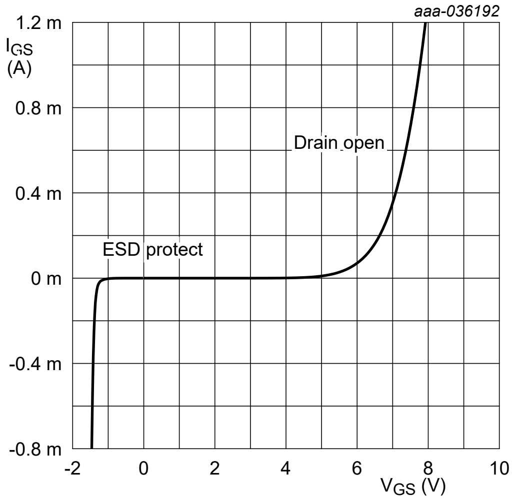
I_D = 17.2 mA ; V_{DS} = V_{GS}

Fig. 8. Gate-source threshold voltage as a function of junction temperature



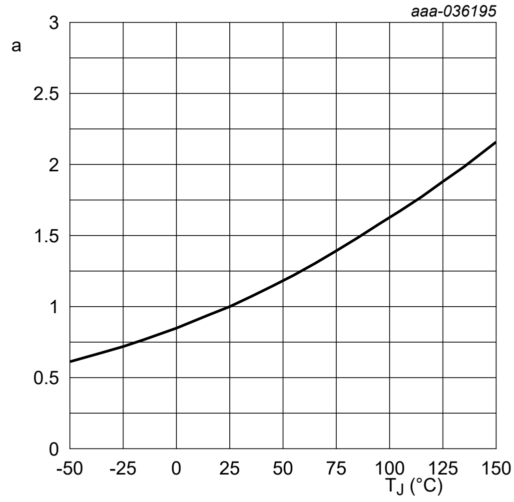
V_{GS} = 0 V

Fig. 9. Drain-source current as a function of drain-source voltage; typical values



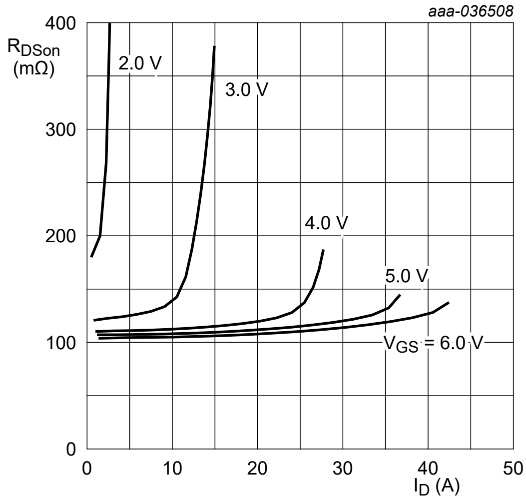
Ig reverse turn on by ESD unit

Fig. 10. Gate-source current as a function of gate-source voltage; typical values



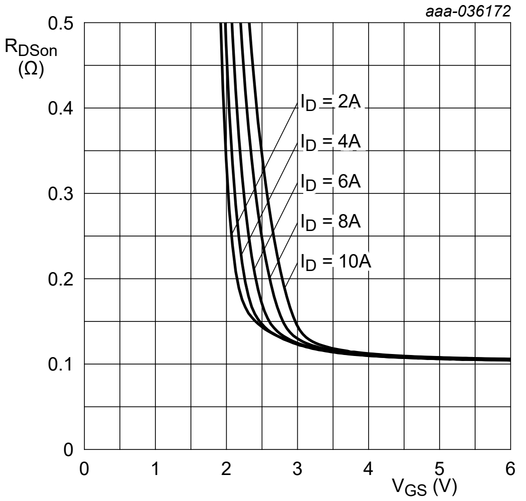
$$a = \frac{R_{DSon}}{R_{DSon\,(25°C)}}$$

Fig. 11. Normalized drain-source on-state resistance factor as a function of junction temperature



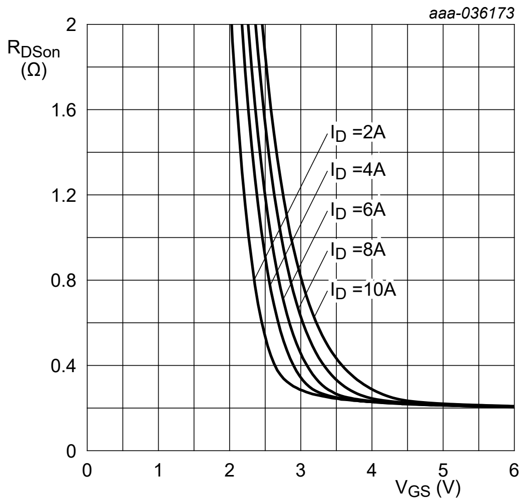
$T_j = 25\ °C$

Fig. 12. Drain-source on-state resistance as a function of drain current ; typical values



$T_j = 25\ °C$

Fig. 13. Drain-source on-state resistance as a function of gate-source voltage; typical values



T_j = 125 °C

Fig. 14. Drain-source on-state resistance as a function of gate-source voltage; typical values

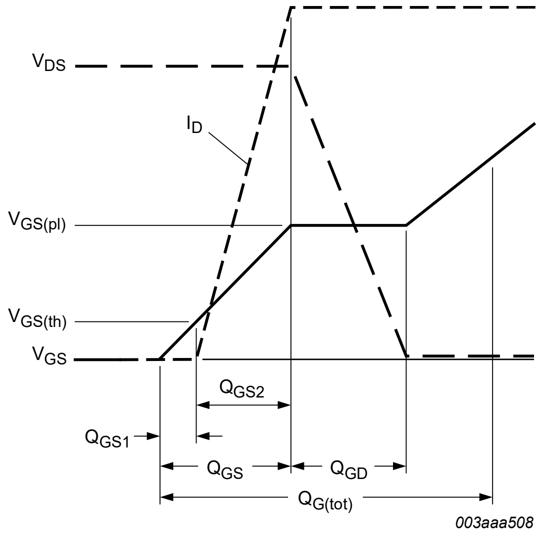
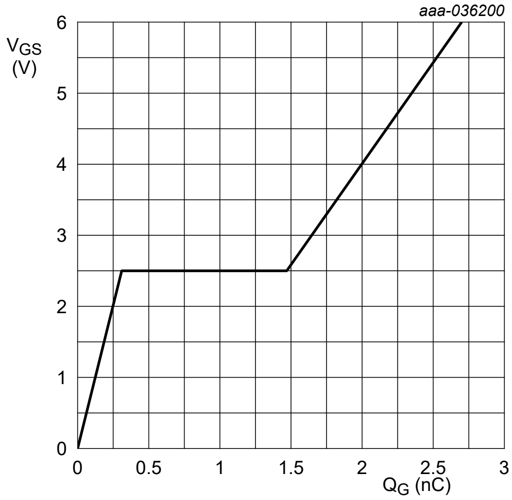


Fig. 15. Gate charge waveform definitions



T_J = 25 ° C ; I_D = 5 A

Fig. 16. Gate-source voltage as a function of gate charge; typical values

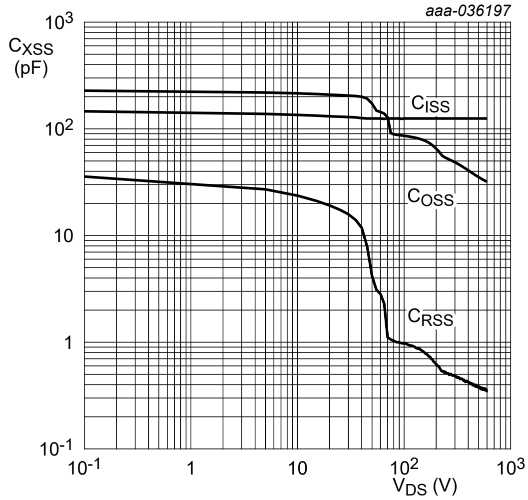
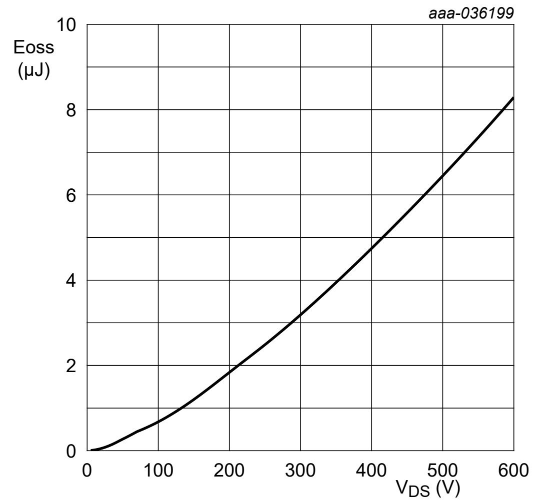
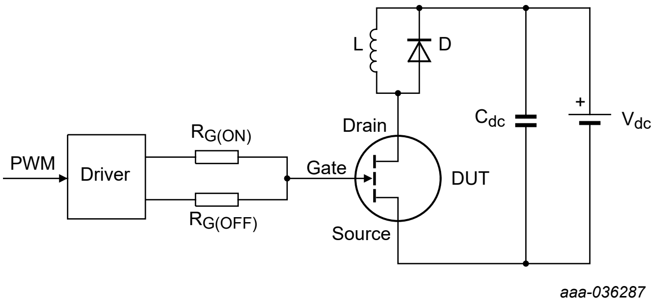


Fig. 17. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



Freq. = 100 kHz

Fig. 18. COSS stored energy as a function of drain-source voltage; typical values



V_{DS} = 400 V; I_D = 10 A; L = 318 µH; V_{GS} = 6 V; R_{on} = 10 Ω; R_{off} = 2 Ω

Fig. 19. Typical switching times with inductive load

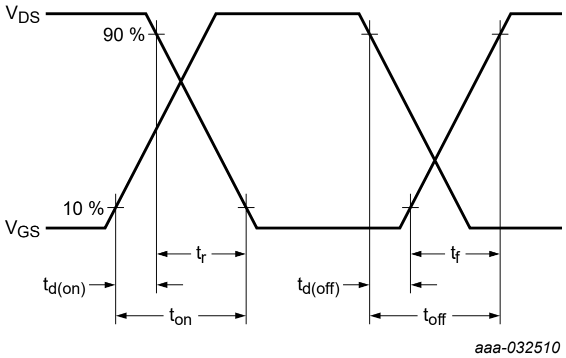
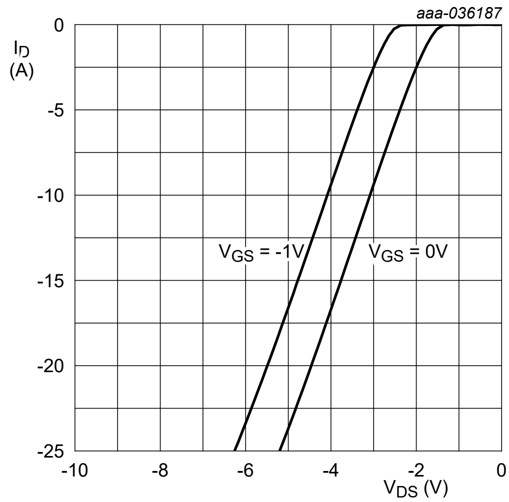


Fig. 20. Switching time waveform



T_j = 25 °C

Fig. 21. Source current as a function of source-drain voltage; typical values

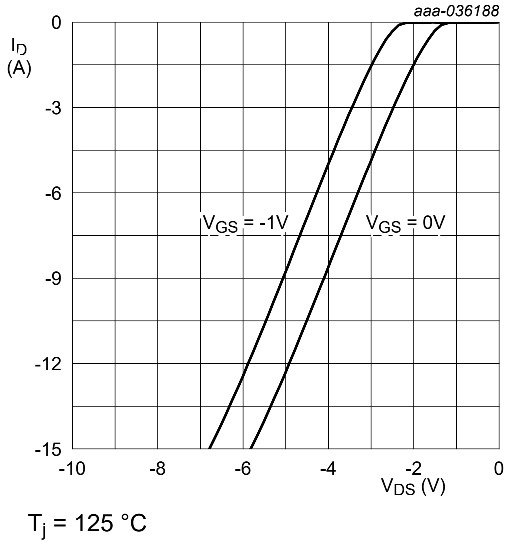


Fig. 22. Source current as a function of source-drain voltage; typical values

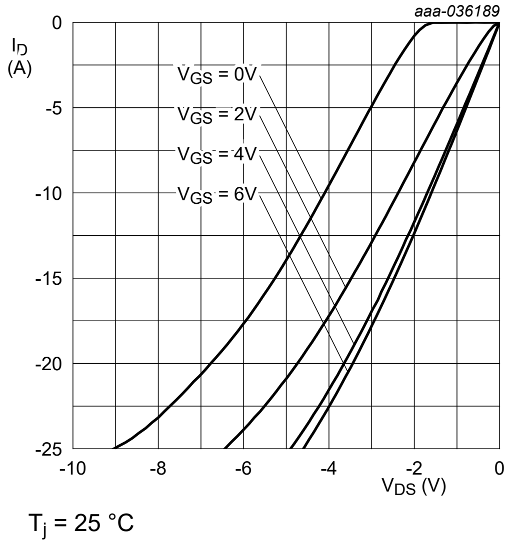


Fig. 23. Source current as a function of source-drain voltage; typical values

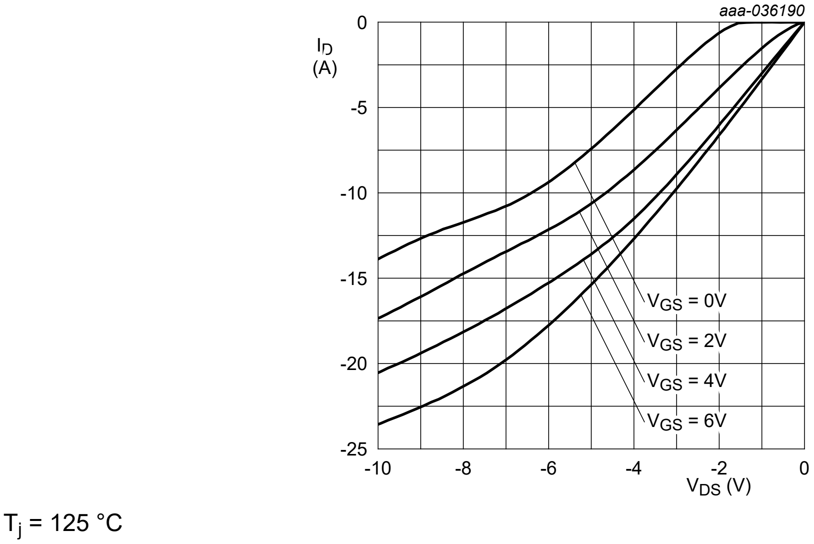
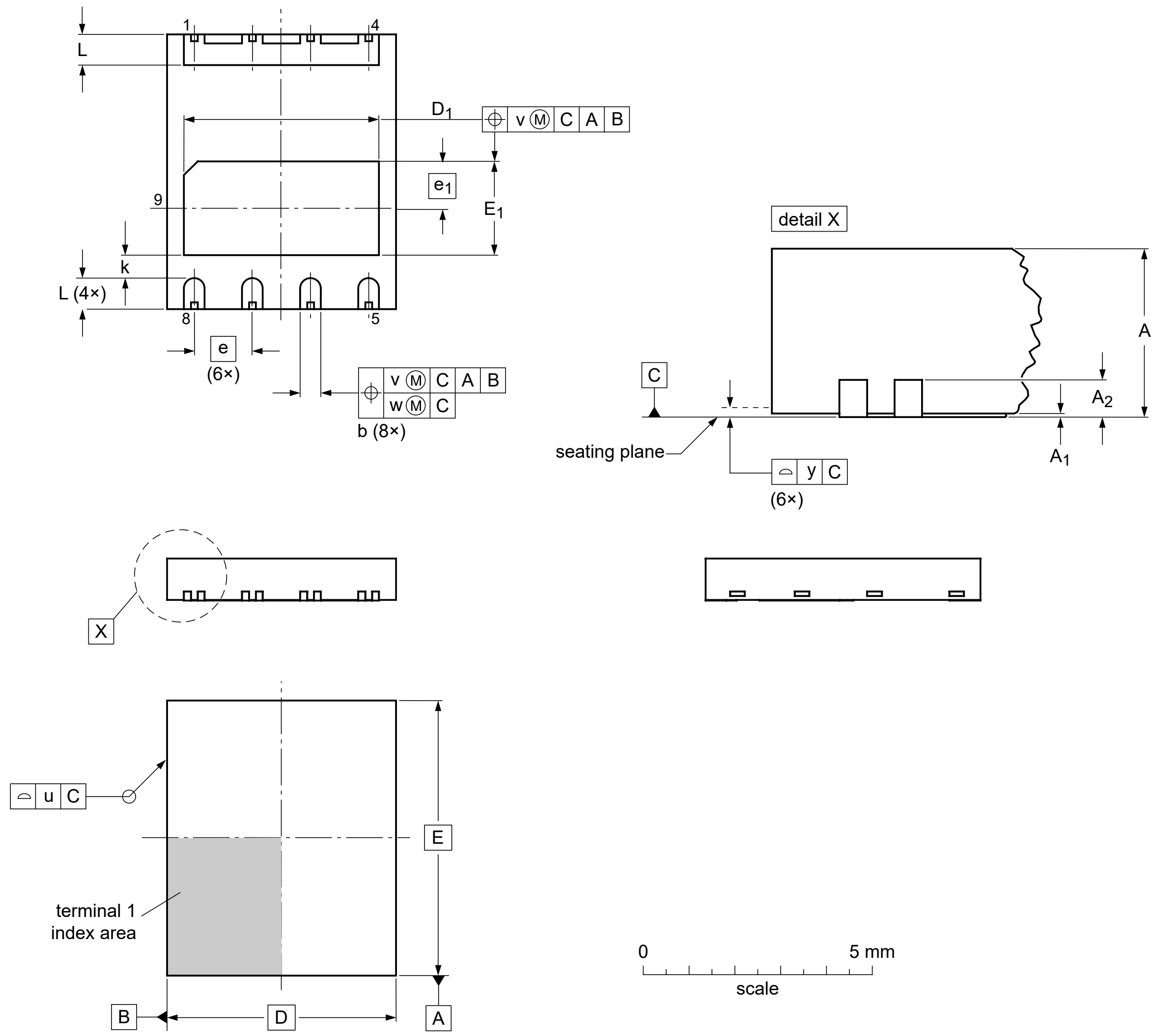


Fig. 24. Source current as a function of source-drain voltage; typical values

11. Package outline

DFN5060-5: plastic thermal enhanced small outline package; no leads; 5 terminals; body: 5 × 6 × 0.9 mm **SOT8075-1**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_2	b	D	D_1	E	E_1	e	e_1	k	L	u	v	w	y
mm	max	1.0	0.05		0.50		4.36		2.15				0.775				
	nom	0.9	0.02	0.203 REF	0.45	5 BSC	4.26	6 BSC	2.05	1.27 BSC	0.8 BSC	0.5 REF	0.675	0.1	0.1	0.05	0.1
	min	0.8	0.00		0.40		4.16		1.95				0.575				

sot8075-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT8075-1		MO-229 compatible				23-03-03

Fig. 25. Package outline DFN5060-5 (SOT8075-1)

12. Soldering

Footprint information for reflow soldering of DFN5060-5 package **SOT8075-1**

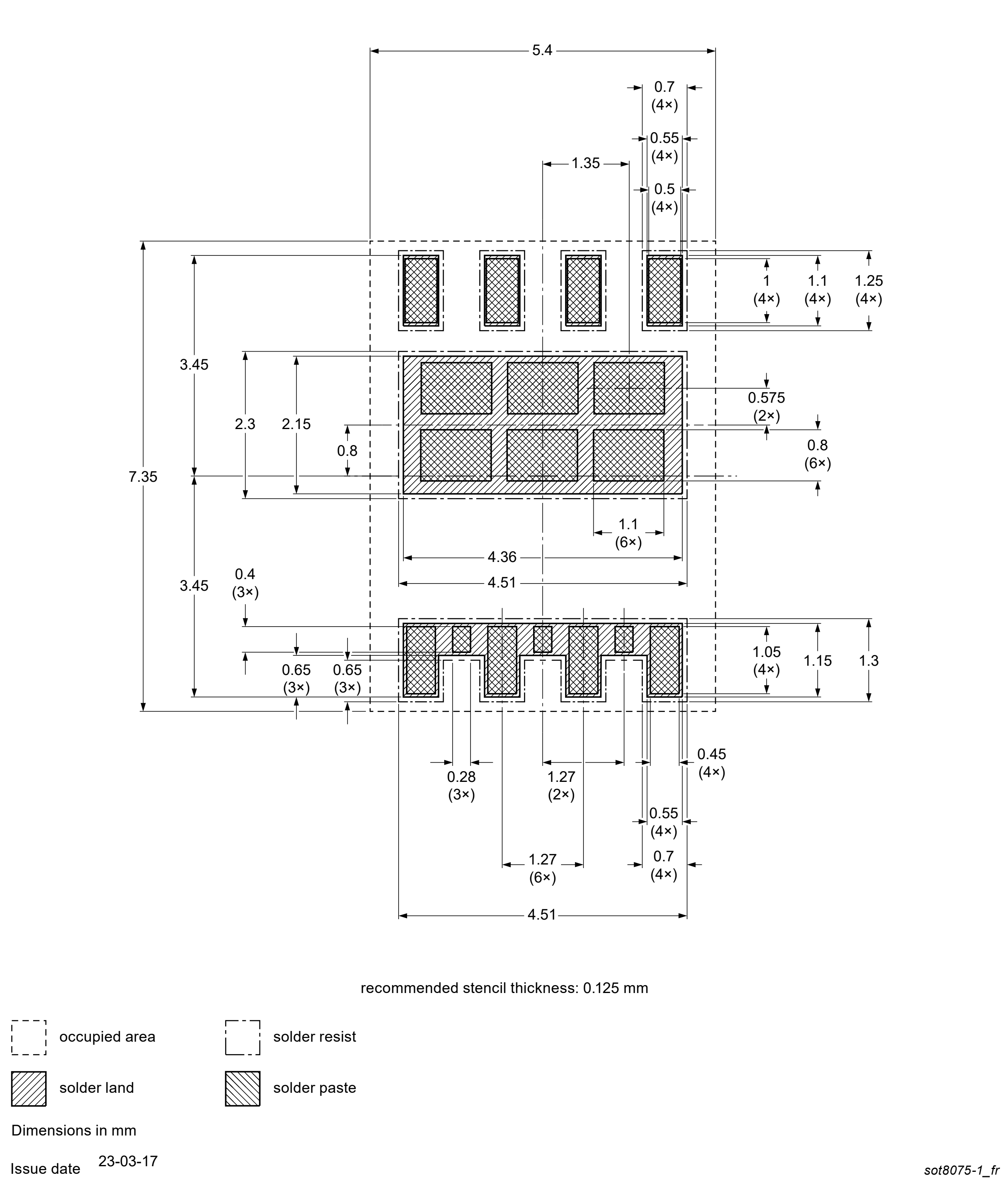


Fig. 26. Reflow soldering footprint for DFN5060-5 (SOT8075-1)

13. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
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